GEOPHYSICAL MODEL OF HOMESTAKE AU

COX AND SINGER MODEL No. 36b

Compiler - **W.D. Heran**

Geophysically similar models - No. 36a Low Sulfide Au-Quartz Veins

A. Geologic Setting

- Mainly within Archean age regionally metamorphosed (greenschist-facies) mafic and felsic metavolcanic rocks, komatiites, and volcaniclastic sediments interlayered with banded iron-formation. Greenstone units typically intruded by felsic plutons and locally by quartz and/or syenite porphyry.
- Deposits are common near regional division between predominantly metavolcanic and metasedimentary rocks in greenstone belt.
- Stratabound to stratiform deposit consisting of bedded ores of native gold with various sulfides in Fe-rich siliceous or carbonate-rich chemical sediments overlying vein and stockwork feeder zones, often interlayered with flow rocks. Beds may be cut by quartz-carbonate veins containing gold. Deposits are commonly structurally controlled.

B. Geologic Environment Definition

Remote sensing data can delineate regional lineaments, major structural zones, lithologic boundaries and areas of hydrothermal alteration (Honey and Daniels, 1985; Crosta and Moore, 1989; Yatabe and others, 1984; Longman, 1984). Greenstone belts can be outlined by aeromagnetic surveys, which may reflect a regional magnetic low if the belt is magnetite-deficient, in other cases a high if it is magnetite-rich (Grant, 1985). Aeromagnetic surveys are used to define regional structures and locate iron rich metasediments and mafic and ultramafic volcanic rock, within the greenstone belt (Lindeman, 1984; Boyd, 1984). Airborne magnetic data may also define intrusive at the edges or within greenstone belts which may be magnetite deficient compared to normal granitoid rocks (Grant, 1984). Combined airborne EM/magnetic surveys have been used in mapping structure within greenstone belts (Boa Hera, 1986). Airborne Radioelement surveys can delineate high potassium zones related to sericite alteration and help define lithologic boundaries (Cunneen and Wellman, 1987). Gravity can be utilized to help determine the depth of belt rocks, define shear zones and folded structures or locate buried intrusive (Costa and Byron, 1988). Electrical soundings and gravity data have been used to model maximum depths of greenstone sequences (DeBeer, 1982).

C. Deposit Definition

Detailed magnetic surveys have been used to map banded iron formations; predict strike extensions, bedding thickness and dip of magnetic zones within the stratigraphic sequence (Lindeman, 1984) and help unravel structure that controls mineralization (Pemberton and others, 1985). Also, detailed magnetic data are employed to map intrusive and dikes associated with ore zones (Koulomzine and Brossard, 1947) and identify alteration which involves both the formation and destruction of magnetic minerals (Fuchter and others, 1991). The strong association of gold with sulfides has permitted the use of a variety of electromagnetic methods to map these zones as conductors (Lindeman, 1984; Valliant, 1985; Costa and Byron, 1988. EM techniques are also used to help map stratigraphy and structure (Pemberton and Carriere, 1985). The induced polarization method is effective in mapping sulfides as resistivity lows and as positive zones of increased polarization (Mathisrud and Sumner, 1967; Sheehan and Valliant, 1985; Hallof, 1985). The IP method can be used to distinguish between mineralized and non-mineralized conductive (EM) anomalies (Costa, and Byron, 1988). IP has been used successfully underground to map pencil-like ore shoots (Mathisrud, and Sumner, 1967). The Mise-a-la-masse electrical technique has been used to delineate the size, shape, and position of individual mineralized units within a sequence (Polomé, 1989). Radiometric surveys can also be used to define areas of hydrothermal alteration (Costa and Byron, 1988).

D. Size and Shape of	Shape	Average Size/Range
Deposit	layered sheet or lens	$0.3x10^6 m^3$, $.03\text{-}3.9x10^6 m^3$
Alteration	irregular	

E. Physical Properties (units)	Deposit	Alteration	Host
1. Density (gm/cc)	3.1[1]; average 2.9-3.4[1]	?	*
2. Porosity	?	?	*
3. Susceptibility (10^{-6} cgs)	500[1] average 0-5000[1]		*
4. Remanence	?	?	*
5. Resistivity (ohm-m)	1[1] average .1-10[1]	?	*
6. IP Effect chargeability (mv-sec/v)	50[1] average 20-200[1]	?	*
percent freq. effect (PFE)	12.5[1] ave 5-50[1]	?	*
7. Seismic Velocity (km/sec)	?	?	*
8. Radiometric			
K (%)	moderate-high	moderate-high	*
U (ppm)	moderate-very high	variable	*
Th (ppm)	variable	variable	*

F. Remote Sensing Characteristics

Remote sensing applications to exploration are based on identifying indirect indicators of potential host rocks including spectral, albedo, and textural characteristics. Potential host rocks composed of iron oxides and carbonate minerals can be uniquely identified with high spectral resolution instruments (imaging spectrometers) in the visible and near-infrared (Rowan and others, 1983; Clark and others, 1990). More importantly, imaging spectrometer data can be used to identify and map the distribution of specific iron oxide species (Taranik and others, 1991). Broad-band data in the visible and near-infrared, such as Landsat Thematic Mapper, are effective for separating carbonate- and iron oxide-bearing potential host rocks from other lithologies on regional and local scales (Knepper, 1989). Enhanced Landsat data have been used to define lineaments, fracture patterns and major structures (Longman, 1984). Airborne MSS data can delineate faults, joints and stratigraphic units (Honey and Daniels, 1985).

G. Comments

Regional exploration for and within greenstone terranes has commonly employed aeromagnetic data and more recently Radioelement and remotely sensed data, in Australia, Canada, and Brazil. In general, greenstone terranes have a low and rough magnetic character, meaning a low background level with numerous intense short-wavelength anomalies (Grant, 1985).

H. References

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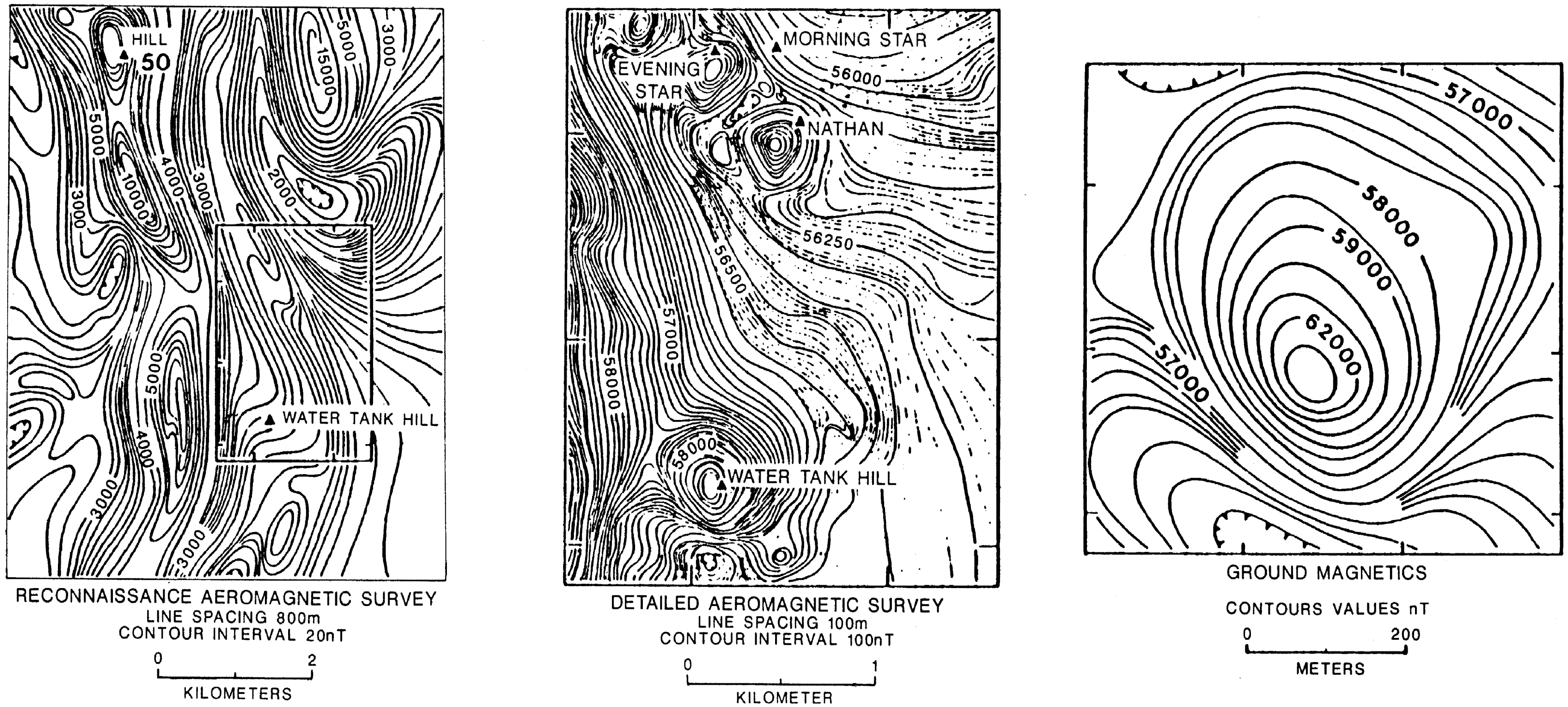

Figure 1. Magnetic data from Water Tank Hill, Mt. Magnet area, Western Australia. The recon aeromagnetic data (800 m) does not define the deposit well, but the detailed (100 m) data show an obvious oval response. Detailed ground magnetics further define its signature. (peak response is 7000 nT above background) (after Lindeman, 1984)

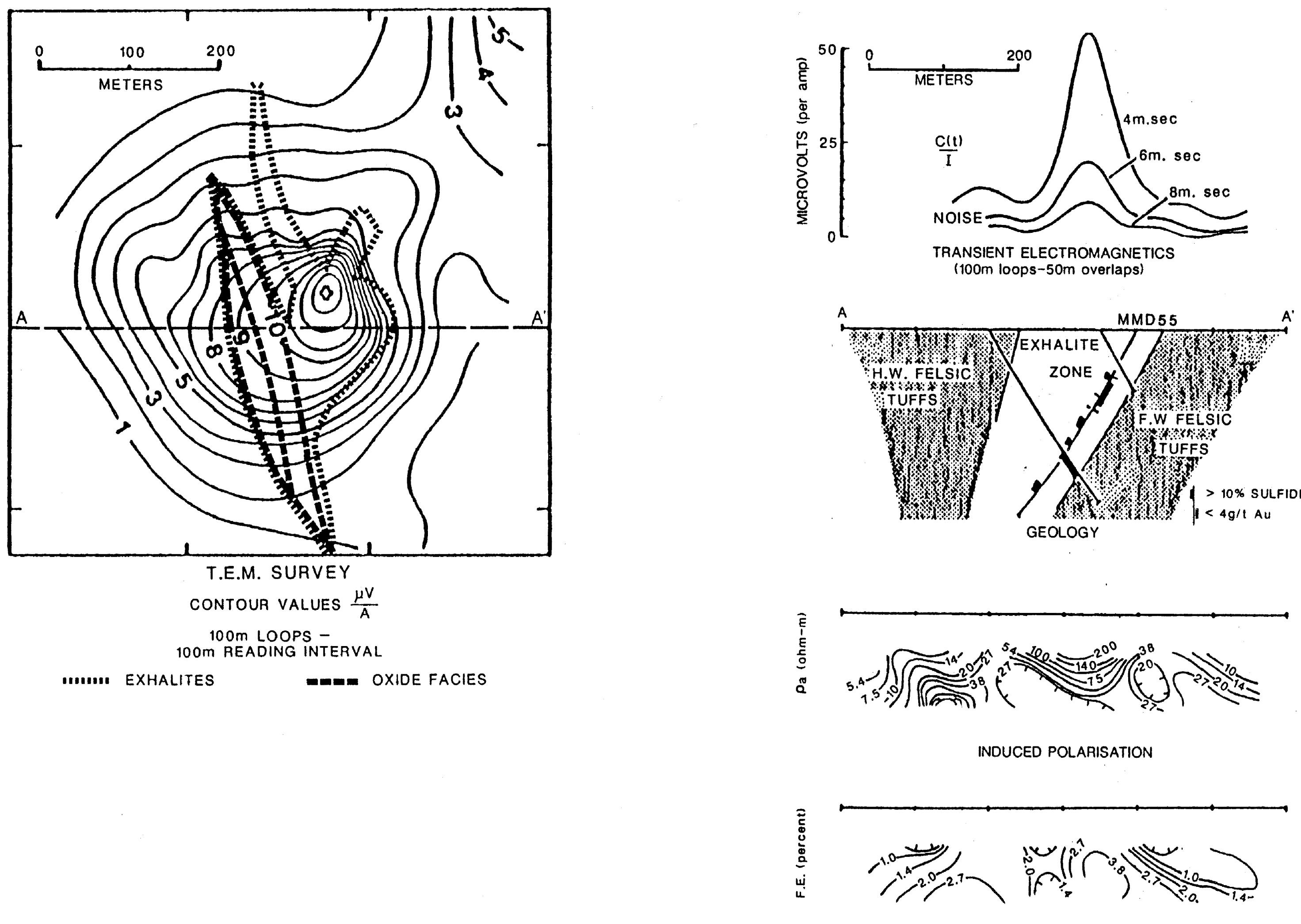

Figure 2. Geology, Transient EM and IP data from Water Tank Hill, Mt. Magnet area, Western Australia. The discovery hole MMD 55 was drilled to test the TEM and IP anomalies. The apparent resistivity high appears to relate to BIF (exhalite zone). (after Lindeman, 1984)

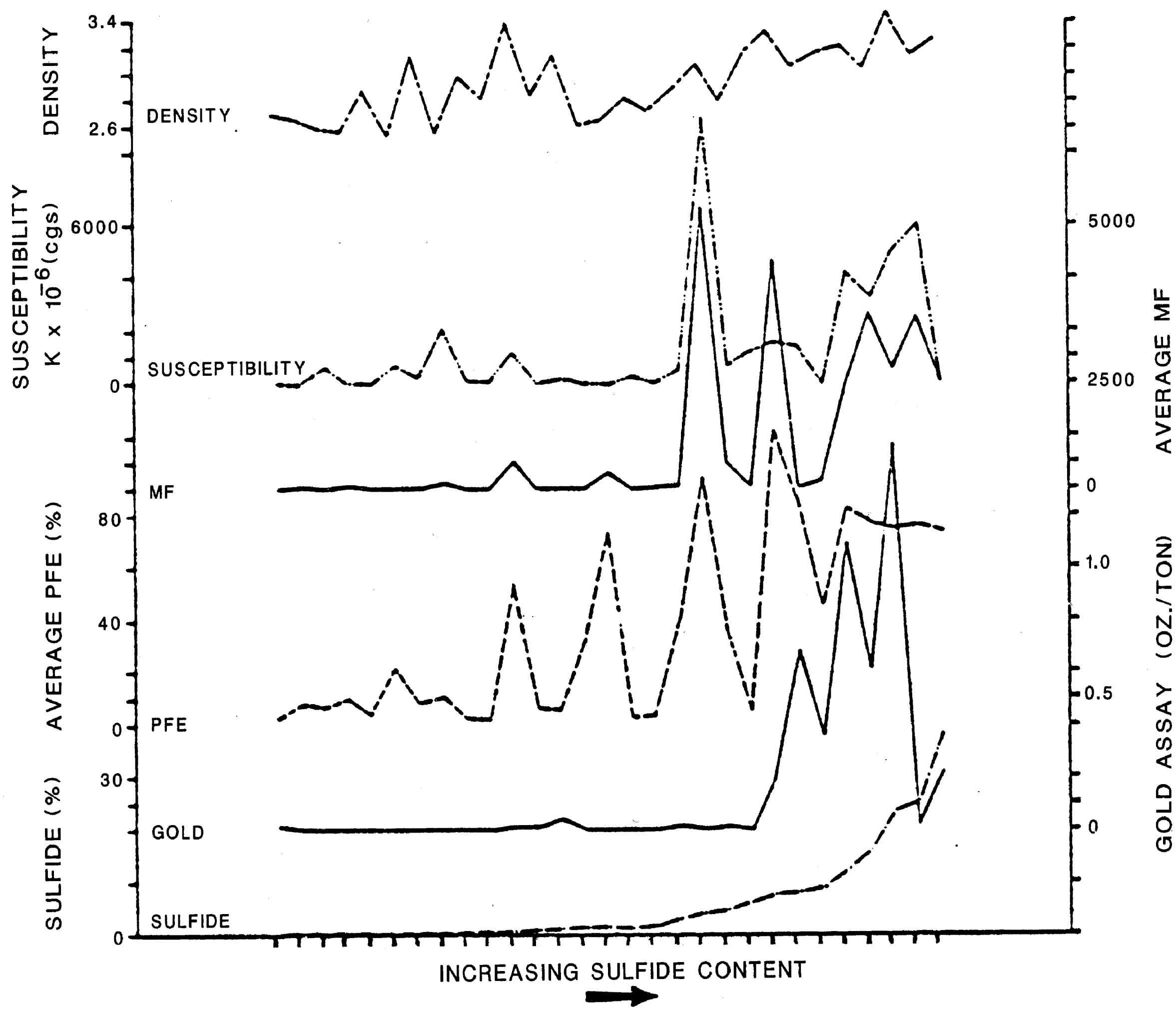

Figure 3. Laboratory physical property measurements on core samples from the Homestake Mine (from Mathisrud and Sumner, 1967).